ENERGY AND MONTANA

AN OVERVIEW

PREPARED FOR THE
ENVIRONMENTAL QUALITY COUNCIL

by the
Montana Department of Natural Resources and Conservation
Energy Division
November 1, 1991

ENERGY AND MONTANA

PRESENTED TO THE ENVIRONMENTAL QUALITY COUNCIL
November 1, 1991
By Alan Davis, DNRC

PRESENTATION NOTES

Page numbers refer to page numbers on attachments.

CAVEAT: DNRC does not collect data. Therefore relied on DOE and other sources. The data is not all from same year. The data definitions may vary be the agency providing it. Anybody with better data should contribute it.

The data presented is from the most recent year, usually calendar year 1989 or 1990. Any long term data used starts in 1970.

This presentation can't be an in-depth discussion of energy. It's purpose is to give a context for discussing energy. To give a sense if production or consumption is BIG OR SMALL, which way things are CHANGING OVER TIME, and WHERE FUEL ENDS UP, by geographic region or consuming sector.

Energy policy should focus on the consumer, the person who needs a product, energy. Otherwise there's no need to differentiate from economic development policy, export policy or whatever you want to call it.

Energy policy should be concerned about end uses, since that's what consumers worry about. Most people don't need gas, oil, or electricity. They need heat, motive power, and light.

Unfortunately, the data generally aren't available in that form. Therefore, I will give you the briefing in the tradition style, starting with fuels.

I'll be presenting facts about physical systems and physical consumption and production. You should keep in mind that these facts, these patterns, are as much a result of political, economic, and regulatory decisions as they are a result of the physical world. In short, they're not accidental.

You should keep one other distinction in mind. The Montana Legislature can take actions in context of a national energy strategy or of a Montana plan. Those contexts often overlap, but sometimes they don't. Sometime actions to support a national energy strategy have little if any direct impact on Montana consumers.

GLOSSARY PAGE 1

OVERVIEW--CONSUMPTION

The three major energy products Montanans consume are oil, gas, and electricity. I'll show how they're changing over time and which sector is using them. Keep this in mind when we switch to discussion of production.

PAGE 2
Petroleum use is concentrated in the transportation and industrial sectors. The increase is most notable in the industrial sector. NOTE that Industrial includes farms and off-highway use such as logging.

PAGE 3
Natural gas use is down everywhere except Transportation. That sector is natural gas consumed as pipeline fuel. The biggest drop is in the Industrial sector, primarily from Anaconda's shutdown. NOTE: Consumption has declined in the Residential and Commercial sectors as well; we don't know why, though some part could be due to conservation.

PAGE 4
Electricity use has expanded greatly, driven by the residential and commercial sectors. NOTE: Almost half of the industrial sector is CFAC.

That's where the fuels go. Now, an overview of how Montana ranks in the production of fuels and how that's changed over time.

PAGE 5
Montana is not among the top-ranked states in the production of any fuel. We do best in coal. Noteworthy that Montana's relative position basically hasn't changed over the decade.

NOTE: The electricity ranking is for all forms of generation. However, for hydro-electric generation, Montana ranks fifth, behind the Pacific Coast states and New York

COAL

PAGE 6
Coal production increased ten-fold from 3.5 million tons in 1970 to 37.5 million tons in 1990. Most of that increase occurred by 1980. Almost all the coal produced is sub-bituminous coal. [SEE TABLE, based on Table 1.1] Only about 0.5% of production is lignite

Almost all current coal production is located in Big Horn and Rosebud counties. However, a major new mine has been proposed near Roundup.

Most of Montana coal is exported. In 1990, almost 3/4 was exported by rail, about 15% could be said to be exported by wire as electricity, and only about 10% was used in Montana, almost entirely for the generation of electricity.

NOTE: Rail export figures computed from Table 3.6, and cross-checked with Table 3.3. Export by wire assumed that MPC used all its output from Corrette and Colstrip 1-3, and that PPL met its Montana load with Colstrip 3&4. Actual use and export patterns are more complicated than that.

Given that most Montana coal is exported rather than used in state, the Legislature should address coal in context of meeting national energy needs rather than those in Montana.

PETROLEUM

PAGE 7

Montana's petroleum production peaked in 1968 and has declined steadily over the last two decades. Changes in price, regulation and taxation appear to have had little affect on this trend, which is probably driven more by geology and timing of discovery and development of major plays. No new significantly large oil fields have been discovered in Montana since 1966 (Powder River Basin). [SEE graph based on Table 1.1]

Most Montana petroleum production occurs in five regions, all east of the Continental Divide, listed here in order of declining crude oil production: the Williston Basin, the Sweetgrass Arch-Bearpaw area, the Big Snowy Uplift, and the northern reaches of Wyoming's Big Horn and Powder River Basins. Williston Basin contains nearly 80% of Montana's oil reserves, and the region produced nearly 75% of Montana's 1990 production, which amounted to nearly 20 million barrels. A barrel equals 42 gallons.

MAP PAGE 8

The petroleum pipelines in the state are basically divided into two systems, one tying together the Williston and Powder River basins, the other linking the Sweetgrass Arch, Big Snowy and Big Horn producing areas. Both pipeline systems move quantities of crude oil from Canada to Montana and Wyoming.

In recent years, 80% of production has been exported from the state, mostly to Wyoming. Connections exist between Montana

refiners and production in the Sweetgrass Arch-Bearpaw, Big Snowy and Big Horn areas. [Based on Table 5.3 and Table 5.4.]

Four refineries-- Cenex in Laurel, Montana Refining in Great Falls, Conoco and Exxon in Billings --provide almost all of the product consumed in the state. Collectively, they get about 55% of their crude oil from Canada and about 35% from Wyoming. The shipments from Canada have increased in relative importance over time.

NOTE: The Canadian Free Trade agreement makes Canadian energy supplies as secure as U. S. supplies and free from tariffs and other policies that have been imposed by Canada in the past. This is a significant new development for oil and natural gas in Montana.

Montana refineries pipe product east to North Dakota, south to Wyoming and as far west as Spokane, Washington. About 1/3 of Montana refinery output is sold out of state. (From Table 1.3 and MPA brochure.) All but 2% of the refinery output is moved by pipeline (MPA brochure).

Montana petroleum production has little to do with Montana petroleum product consumption. Less than 10% of the refined products consumed in state are made from Montana crude. Oil should be viewed in the context of meeting national energy needs rather than those of consumers in Montana.

Other notes:
--one price for oil, varies with location and quality, but traded as a commodity on NYMEX, instant price posting
--even if totally independent from foreign oil, still subject to world price and its fluctuations because of world commodity pricing

PAGE 9
Petroleum product consumption peaked in 1979, the year of the Iran crisis. [SEE graph based on Table 1.3] NOTE upswing in 1985 may be a data error.

PAGE 10
Most of the consumption consists of gasoline and distillate fuel, primarily for diesel engines. [SEE graph based on Table 5.7.]

NATURAL GAS

Natural gas volume is measured in units of cubic feet, where "mcf" means thousand cubic feet and "bcf" means billion cubic feet. A standard mcf at 1 atmosphere pressure yields about 1 million Btu, the major hydrocarbon present being methane. The Btu value of an mcf of gas is related inversely to the

atmospheric pressure at the burner tip, thus the higher the altitude, the less heating value per mcf. The typical mcf sold in Montana has slightly over .9 million Btu. As a yardstick, a typical household uses 2-4 mcf/month for domestic water heating.

Natural gas occurs in reservoirs more or less alone (called "non-associated gas") and associated with crude oil (called "associated gas"). Of Montana's 1990 gross gas withdrawals, some 51.5 million mcf, about 15% flowed from oil wells, the rest from gas wells. The largest associated gas reservoirs occur in the Williston Basin and the Sweetgrass Arch. The largest gas production occurs in or around the Tiger Ridge/Bearpaw, Cut Bank, and Bowdoin (pronounced "buh-doyn'") fields, and the Cedar Creek Anticline area on the southeast fringe of the Williston Basin.

PAGE 11
Gas production has remained relatively steady throughout the last decade and a half, fluctuating between 45 and 55 bcf per year.

PAGE 12
Natural gas pipelines serving the state can be roughly divided into east and west sectors. Unlike the oil pipelines, these gas lines are linked. The Williston Basin Interstate (WBI) pipeline drains the Bowdoin, Powder River and Cedar Creek Anticline fields, with net flow generally toward the Dakotas. The WBI southern leg usually moves gas from Wyoming to North Dakota, serving Montana customers en route. At Warren, WBI interconnects with Montana Power Company's (MPC's) gas pipeline. Movement of Canadian gas through WBI, which has complex flow patterns, is possible through contractual "backhaul" arrangements, rather than through simple unidirectional flow.

Montana Power Company (MPC) serves central and western Montana customers with Montana gas gathered predominately in the Cut Bank and Tiger Ridge/Bearpaw regions, supplemented heavily with gas from southern Alberta. About 1/3 of MPC's 1990-1991 gas sales was Canadian gas, about 85% of this originating from the Aden area southeast of Lethbridge--2/3 Montana gas. THUS, A SUBSTANTIAL PORTION OF THE GAS CONSUMED IN MONTANA COMES FROM OUTSIDE THE STATE.--NOTE again Canadian Free Trade Agreement.

MPC also has some production and storage on the south end of its system, in the vicinity of Red Lodge. The system is designed to serve the loads of its central service area, so during peak gas flow, movement is generally from the supplies of the north or south toward the cities of the central core (to show the core, draw a circle around Great Falls, Big Timber, Dillon, Missoula, etc.). MPC's interconnect with the NOVA system at Carway is and will likely become a very important interconnect.

Nearly 20% of Montana's natural gas production is currently under contract for markets in the Midwest and East through the Northern

Natural pipeline system. This gas originates in the Tiger Ridge/ Bearpaw area, and is moved north into southern Saskatchewan to pipelines pushing east. Northern Natural has two presently un-utilized physical connections with MPC's system. Current producer contracts for most of this gas terminate in the next couple years. While some investment in compression would be necessary, this gas could compete with Canadian gas for the Montana consumer market, and be shipped on MPC's pipeline to markets south.

A recent Montana Public Service Commission order allows MPC to restructure its gas utility to include unbundled transportation service of shipper owned gas. The order in effect deregulates part of MPC's gas utility. MPC can now, for instance, transport Canadian gas from the Carway-NOVA pipeline interconnect near Glacier Park to large customers on MPC's system, or move gas south to the WBI and Colorado Interstate Gas (CIG) pipelines. (The CIG interconnect is scheduled to be functional by late November this year.) Canadian gas, currently some of the cheapest in North America, is in great demand to the south. MPC could keep its excess pipeline capacity full transported gas. To take full advantage of these opportunities, MPC must modify its traditional inwardly directed operations to allow for unhampered flow gas from off-system suppliers and/or to off-system destinations.

Increased access to gas sellers and buyers should increase competition throughout the regional natural gas market, with gains for Montana gas consumers and producers alike. A major portion of the Montana market, long enclosed largely by the MPC system, will enter the greater North American continental gas commodity market.

Deregulation of the natural gas industry, nationally and in Montana is moving gas to trading like oil on a commodity like basis. NYMEX sees gas commodities as its new growth sector. Montana producers will be able to sell in a national market, but must be able to compete with price. Montana consumers will also be able to shop the market for the lowest cost supplies.

All indications now are that the gas bubble will not burst--proven reserves are growing faster than consumption--gas prices are likely to remain stable or low in the foreseeable future. Also the link between oil and gas prices now appears to be broken.

Beginning November 1, five state institutions (U of M, NMC, Mt. St. Prison, Warm Springs and Boulder Devel. Center) are participating in MPC's three year phase-in to open access gas transportation. The state stands to reduce its gas costs by over one half for eligible facilities, amounting to a possible annual aggregate savings of nearly $1.5 million for these five

facilities alone. The Pine Hills School For Boys, in Miles City, burns shipper owned gas delivered on Montana-Dakota Utilities' system.

PAGE 13
As noted earlier, natural gas use has declined steadily through most of the last 20 years. Consumption bottomed out in 1987, but it's not clear if the long term trend is toward increased consumption.

ELECTRICITY

Definitions: Electricity is sold by the Kwh. 500 kWh is an amount residences commonly use per month for lights and appliances.
A megawatthour (MWh)= 1000 kWh

The ability of a plant to produce electricity is measured in MW. It is referred to as capacity. Production over some unit of time is called energy. A plant with one MW capacity running flat out for one hour would produce one MWh of energy. Yearly energy production can be summarized as average production by dividing annual production by 8760 hours per year. These are called average MW.

SEE TABLE IN PACKET--PAGES 14 and 15
There are over 4700 MW of generating capacity in Montana. (Table 2.1) lists most of those that generate electricity for resale. It doesn't have the waste coal plant near Colstrip, with a 35 MW capacity and an annual output of 30 aMW. Also not included are a few small hydro facilities and some small wood fired facilities. The winter capacity of the hydro system actually is 33 MW less than shown since icing affects the run of river dams on the Missouri.

PAGE 16
Over the last 20 years, same time frame as MFSA, production has risen 2.5 times and the state has shifted from one that is predominately hydro-based to one slightly more dependent on coal than hydro. [SEE TABLE based on first three categories of Table 2.2] Montana net energy generation in 1990 was 2935.8 aMW. Almost 42% was from dams, while almost 58% was from coal plants. Less than 1% was generated from oil, gas, and wood. Contrast with the Power Planning Council's region that is 16% coal and 62% hydro.

PAGE 17
Utilities may be described by when their maximum loads occur. Montana as a whole is a winter peaking area, though MDU and some coops see their maximum load during the summer. The peak load is

driven by the residential sector [SEE GRAPH]. The Pacific Northwest also is winter peaking, but most of the country is summer peaking.

PAGE 18
Montana is served by three investor owned utilities (or IOUs): Pacific Power and Light, serving the Kalispell-Libby area, Montana-Dakota Utilities, serving areas east from Wolf Point and Hardin, and Montana Power Company, serving the other areas. 29 public organizations, mainly rural electric coops provide service in rural areas and small towns state wide. Bonneville Power Administration has 1 Direct Service Customer (or DSI), the Columbia Falls Aluminum Company. Total retail sales in 1990 and approximate number of residential customers is shown in the table.

PAGE 19
Consumption has increased by one-third since 1970. This has been due mostly to growth in the residential and commercial sectors.

PAGE 20
End use sales state-wide in 1990 (table 2.3; exports from 2.2).

Net exports were over two-fifths(40%) of generation; however, in an integrated system, it's not meaningful to discuss which plant generates which electron flow.

MAP PAGE 21
The western U.S. and western Canada make up a very well-integrated electrical grid, in which power flows from generators to loads over multiple paths determined by physical laws and without reference to ownership or intent. There are no valves on the electrical system. The eastern U.S. (together with eastern Canada) is also a well-integrated electrical grid. However, the eastern and western grids are not synchronized and therefore cannot be directly connected to each other.

However, indirect connections exist, either AC-DC-AC convertor stations or multiple unit hydroelectric facilities where individual units can be shifted to either grid. Convertor stations can be built more or less at will, but they are very expensive and difficult to justify.

The dividing line between the two grids is in eastern Montana. MDU's system is entirely on the east grid. Eastern Montana coops are served by WAPA and Basin Electric G&T, both of which have resources in each grid. Fort Peck Dam can supply power to either side, and the Miles City convertor station can transfer up to 200 MW between the two systems. The Miles City convertor station is owned by the Western Area Power Administration (WAPA), a federal power marketing agency. The size of the convertor station places an effective size limit on the power transfers that can take

place from Montana to the midwest. Note the political boundaries of the states do not coincide with the grid system or utility boundaries.

The Miles City converter was used for several years to transfer 180 MW of Basin Electric Coop power from North Dakota to WAPA's Central Valley Project in California. Currently it is being used to carry Basin power to the Bonneville Power Administration, another federal power marketing agency.

The transmission system is generally considered full in Montana. It is a limiting factor for electricity exports for the state. You must be able to get the power to market. Transmission is expensive to build, it alters resource costs. The implication to Montana is that we will likely need to consider large facilities for export sale to be able to justify construction the new lines. Not likely to build 50 MW facilities for export sale.

Electricity generation is being deregulated. Old PURPA rates are being replaced by competitive bidding schemes, like the one MPC currently has out. This has implications to both resource developers and to ratepayers.

RENEWABLES

Hydro

The major renewable in Montana is hydro. Almost 42% of the electricity produced in 1990 came from hydro.

In addition to the 23 dams shown in [the earlier table], 13 small dams provide 4.9 MW of capacity. (Data primarily from MPC QF file.)

Most potential sites for large dams have been developed. The bulk of the remaining sites are environmentally or economically poor ideas. EG, the Allenspur dam site south of Livingston.

There is some potential for small sites on existing dams or irrigation drops and for some small run of river facilities.

Biomass-wood

Biomass use in Montana primarily is wood burned to provide heat.

In 1990, at least 650,000 tons of oven-dried wood were used in 33 commercial and industrial concerns. This provided an amount of delivered heat roughly equivalent to 40 percent of the heat provided by natural gas to these same sectors. (BUC survey)

In 1988, an estimated 379,000 tons of wood were burned in residences state-wide. This provided an amount of delivered heat roughly equivalent to 25% of the heat provided by natural gas to residences. (BUC survey)

Two wood fired generating plants, at Libby and Missoula, have a capacity of 18.5 MW.

7 wood pellet plants manufactured about 60,000 tons of wood pellets in 1990.

Biomass-ethanol

At present, only one ethanol plant, at Ringling, is in operation. Five other plants no longer are in operation. Alcotech's plant at Ringling produced 2.2 million gallons in 1990. Most of that was sold out of state, probably in response to the structure of Montana's ethanol tax incentives. Montana's tax incentives go to the producer, in some surrounding states they go to the distributor.

4.38 million gallons of ethanol blend (mostly 10% ethanol) were sold in 1990. It came mostly from Cenex plants in North Dakota.

Ethanol is sold at 21 stations across the state. (NOTE: Shirley Ball says the number is higher, but a DoT-industry survey recently only came up with 21.)

Wind

MPC has three small contracts, all at Livingston. In 1990, these produced 32.1 akW.

PAGE 22
There is renewed interest in wind, now that the technology has improved. Wind developers are actively looking at three sites: Livingston, the Blackfeet Reservation and Norris Hill, north of Ennis. [SEE TABLE] NOTE The Livingston Site presented here is not the one at which the previous machines were erected. That turns out to be one of the lowest wind speeds on the Livingston bench.

NOTE: None of these areas are well-defined. For instance, the Livingston wind area probably runs east past the Shields River.

The Power Council says Blackfeet Reservation has a technical potential of 4000 average MW. However, only 140 aMW (450 MW) is considered certain enough to include in their plan. Much of this reduction has to do with transmission constraints.

Solar

Little happening with solar in Montana. However, Forest Service, railroads and others are making extensive use of solar photovoltaics in remote areas.

Solar can be a major contributor to reducing the heating load on houses. For instance, solar can meet 10-20% of the heating load of a conventional house, and more if designed toward that end.

In the longer term, look for dispersed PVs, starting with remote houses using PVs instead of line extensions. Don't expect the solar thermal plants, like the 100 MW Luz has down in California.

Geothermal

Geothermal water is widely available, with many natural hot springs in western Montana and aquifers in the Madison formation under much of eastern Montana.

Given existing technology and economics and considering water quality, especially in eastern Montana, there's unlikely to be much geothermal development other than for small-scale local use.

Cogeneration

Little happening in Montana, other than the wood fired plants mentioned above, which also provide steam to lumber and pulp operations. The university system is being approached by cogeneration developers.

TRANSPORTATION

PAGE 23
Gasoline and diesel use for transportation peaked in the late 1970's and has since dropped off. [SEE GRAPH, based on Table 5.11.)

PAGE 24
The pattern of Montana gasoline use is different than the national pattern. The spike in summer use is much more pronounced. (Highway Stats 1989, p10.)

Montana ranks second in terms of diesel fuel use as a percentage of total highway use of motor fuel. In 1989, 22% of highway fuel was diesel. (Table 5.5)

There's about 530 service stations in Montana. (MPA Petroleum Facts)

Montana is near the national average in terms of private and commercial automobiles per capita (1989). Montana is 0.54 per capita; national average is 0.57. This is slightly lower than the surrounding states and the Pacific Northwest. (Highway Stats 1989, p16.)

CONSERVATION

There is no state-wide data on conservation potential. The Northwest Power Planning Council has estimates for efficiency improvements in the use of electricity in western Montana. Montana Power has estimates for potential for similar improvements in its electricity service area. However, we can provide three examples that give some flavor of the potential.

By the year 2000, MPC expects that its energy load will grow by 135 aMW. MPC expects to meet half its load growth through conservation.

Since 1985, BPA has sponsored the Super Good Cents Program to encourage people building electrically heated homes to aim for high levels of energy efficiency. 262 houses, about 20% of the new electrically heated houses in BPA's service territory, have been certified as Super Good Cents houses. Perhaps that doesn't sound like much, but those houses already are providing over 1 MW of peaking capacity.

NOTE: Assumes the yearly peak is driven by heating load and that SGC houses have an average of 4 kW installed heating capacity less than conventional houses. In Houser's (MPC's) June 1988 evaluation of SGC, he estimated 6.5 kW less was installed.

PAGE 25
Fleet efficiency appears to have improved since 1970. Using Montana Department of Transportation estimates on mileage and DOE estimates on the sales of gasoline and diesel, the MPG obtained by vehicles in Montana has increased by about 30%. We can't say what the reason is, but the data show that significant changes in efficiency have been possible. NOTE: This change could have been caused by changes in driving patterns or some other reason.

ATTACHMENTS

ENERGY AND MONTANA

GLOSSARY

Average MW: Abbreviation for average Megawatt. A unit of energy output over a specified time period, equivalant to the total energy in MWh divided by 8,760 (the number of hours in a year).

Barrel: 42 U.S. gallons.

bcf: Abbreviation for billion cubic feet. See mcf.

Btu: Abbreviation for British Thermal Unit. A measure of heat content being the quantity of heat necessary to raise the temperature of 1 pound of water 1 degree Fahrenheit (elevate 59°F to 60°F, at 1 atmosphere pressure).

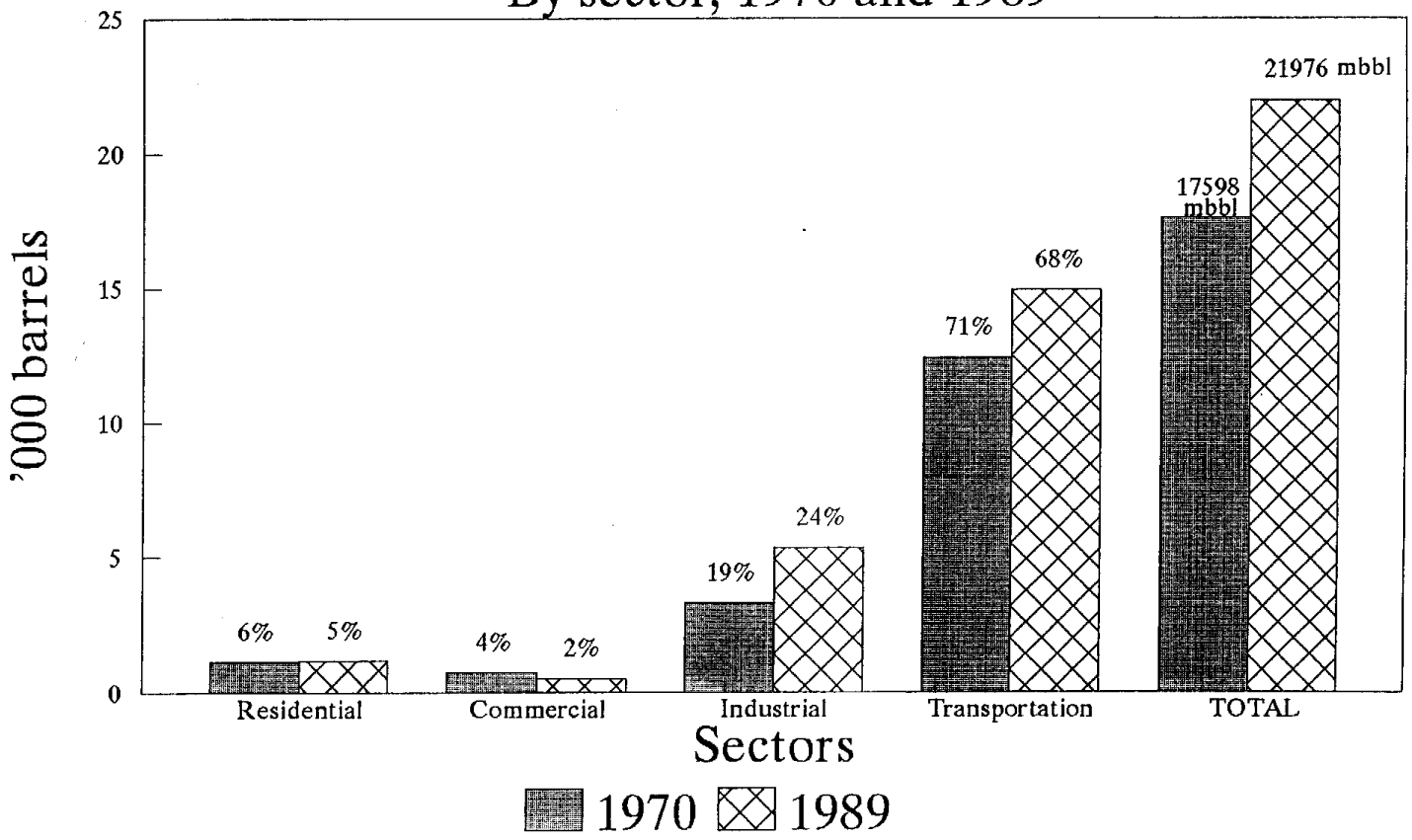
kWh: Abbreviation for kilowatt-hour. A watt is an electrical unit of power or rate of doing work, where 746 watts equals about 1 horsepower. A kilowatt-hour is one thousand watts supplied/consumed steadily for one hour. A kWh contains approximately 3,412 Btus.

mcf: Abbreviation for thousand cubic feet. A measure of gas volume. Burning 1 mcf of natural gas at 1 atmosphere pressure releases roughly 1 million Btus of heat.

MWh: Abbreviation for megawatt-hour, one million watt-hours. See kwh.

PETROLEUM USE

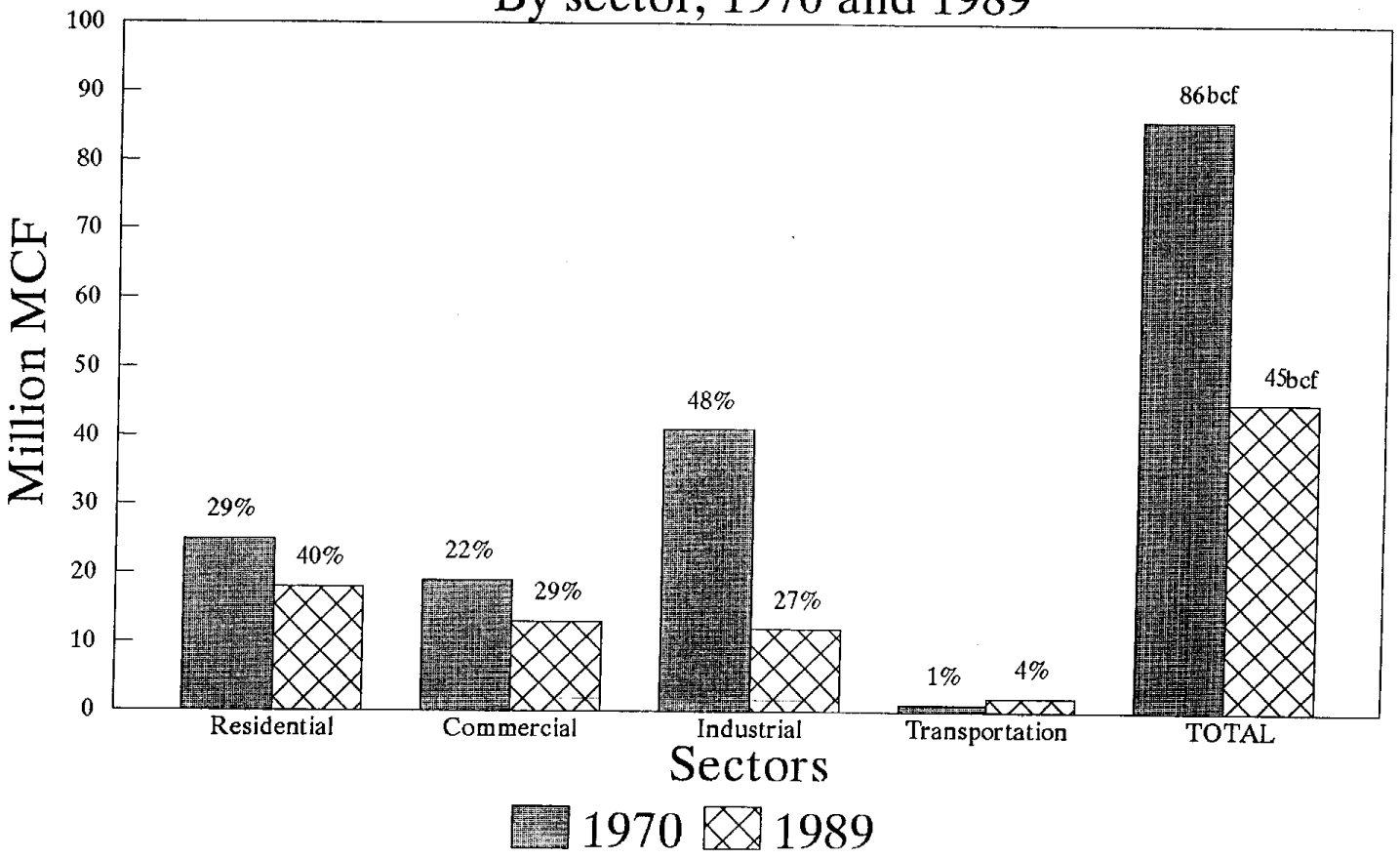
By sector, 1970 and 1989



NOTE: Industrial sector consumption does not include refinery use or asphalt; does include farm and off-highway use. The percentage of annual consumption is above each sector bar.

NATURAL GAS USE

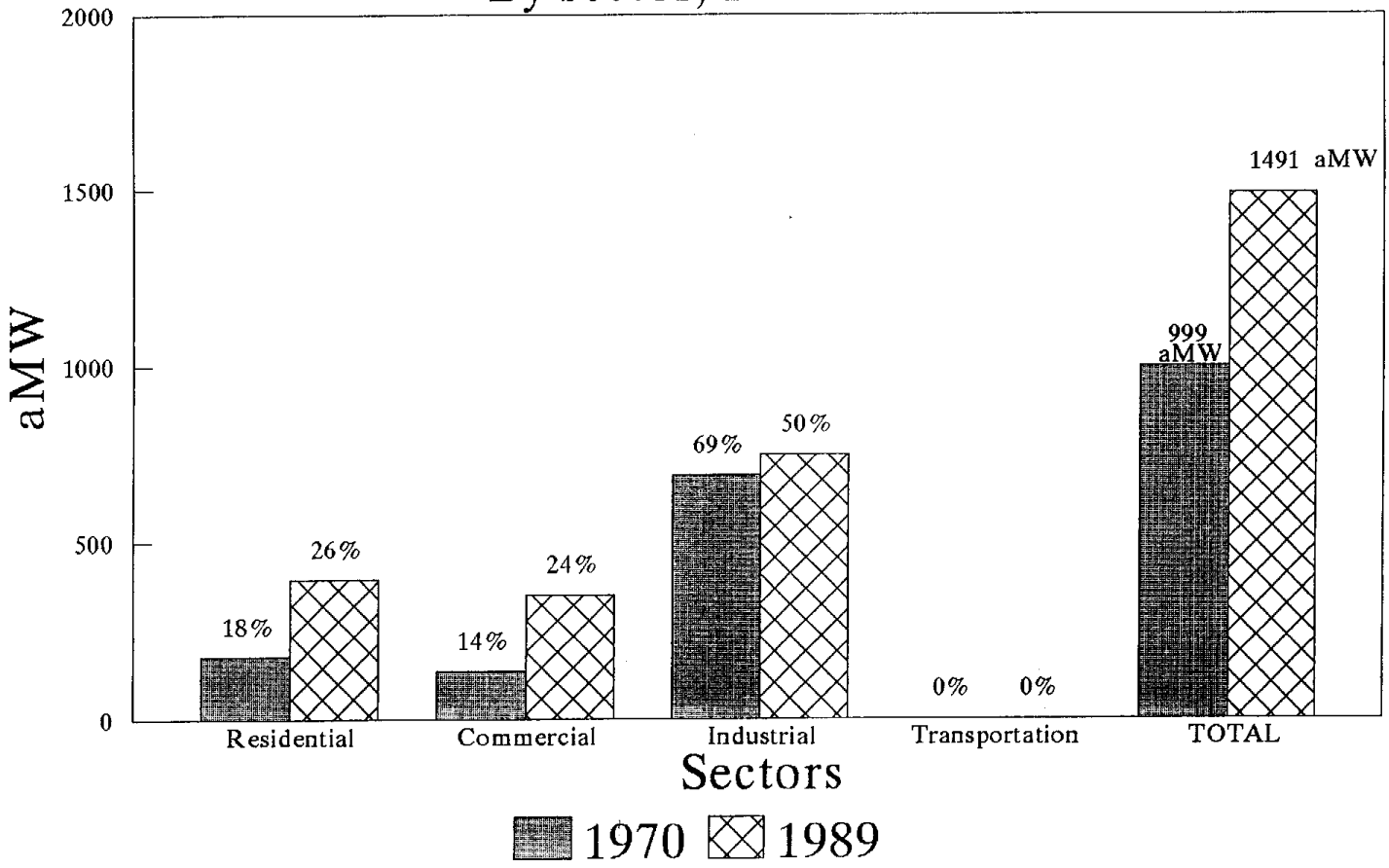
By sector, 1970 and 1989



The percentage of annual consumption is shown above each sector.

ELECTRICITY USE

By sector, 1970 and 1989



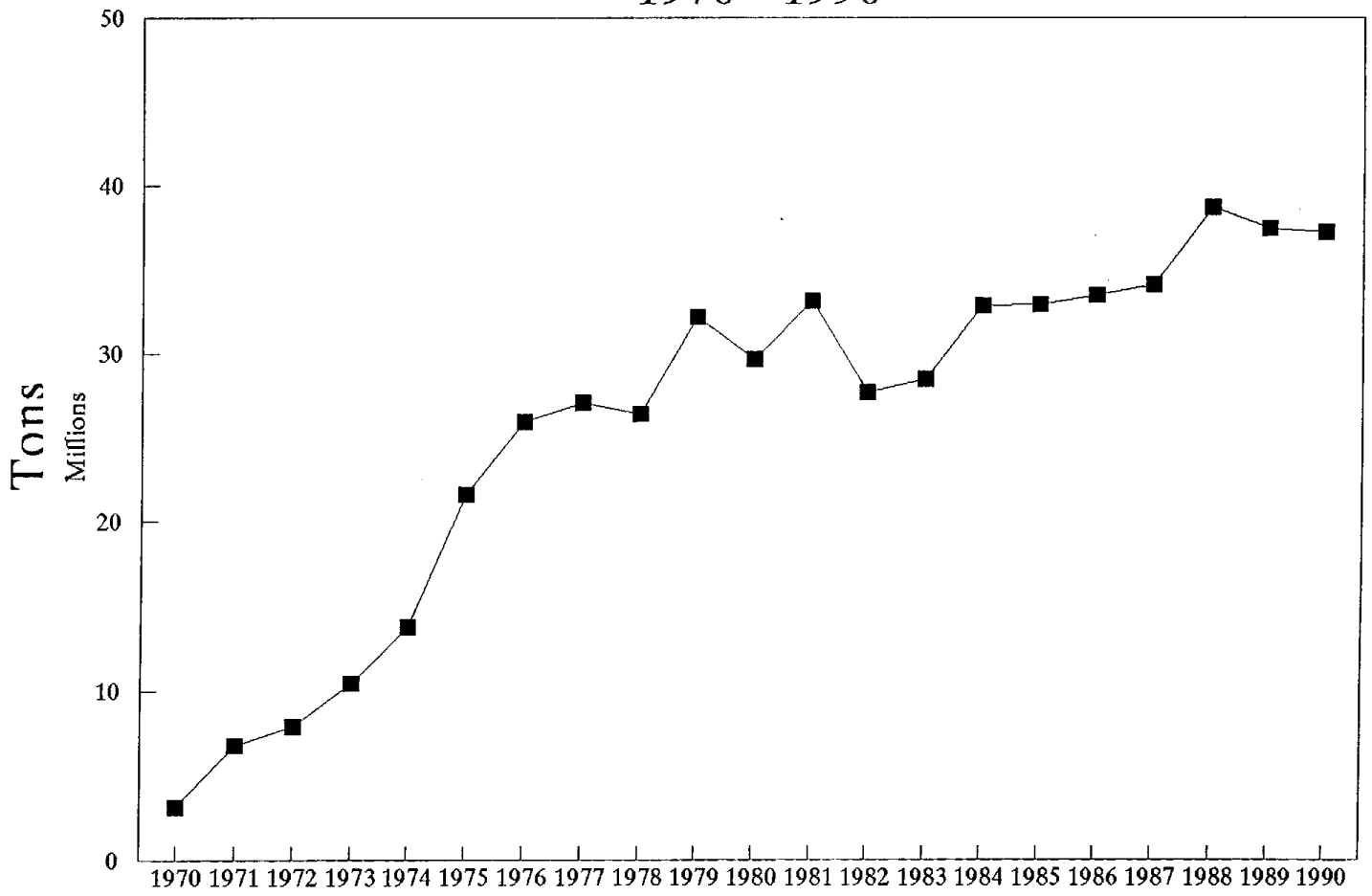
The percentage of annual consumption is above each sector bar.

Montana's Rank Among Producing States

	1980	1990
Coal	9	8
Crude oil	14	14
Natural gas	16	18
Electricity	39	38

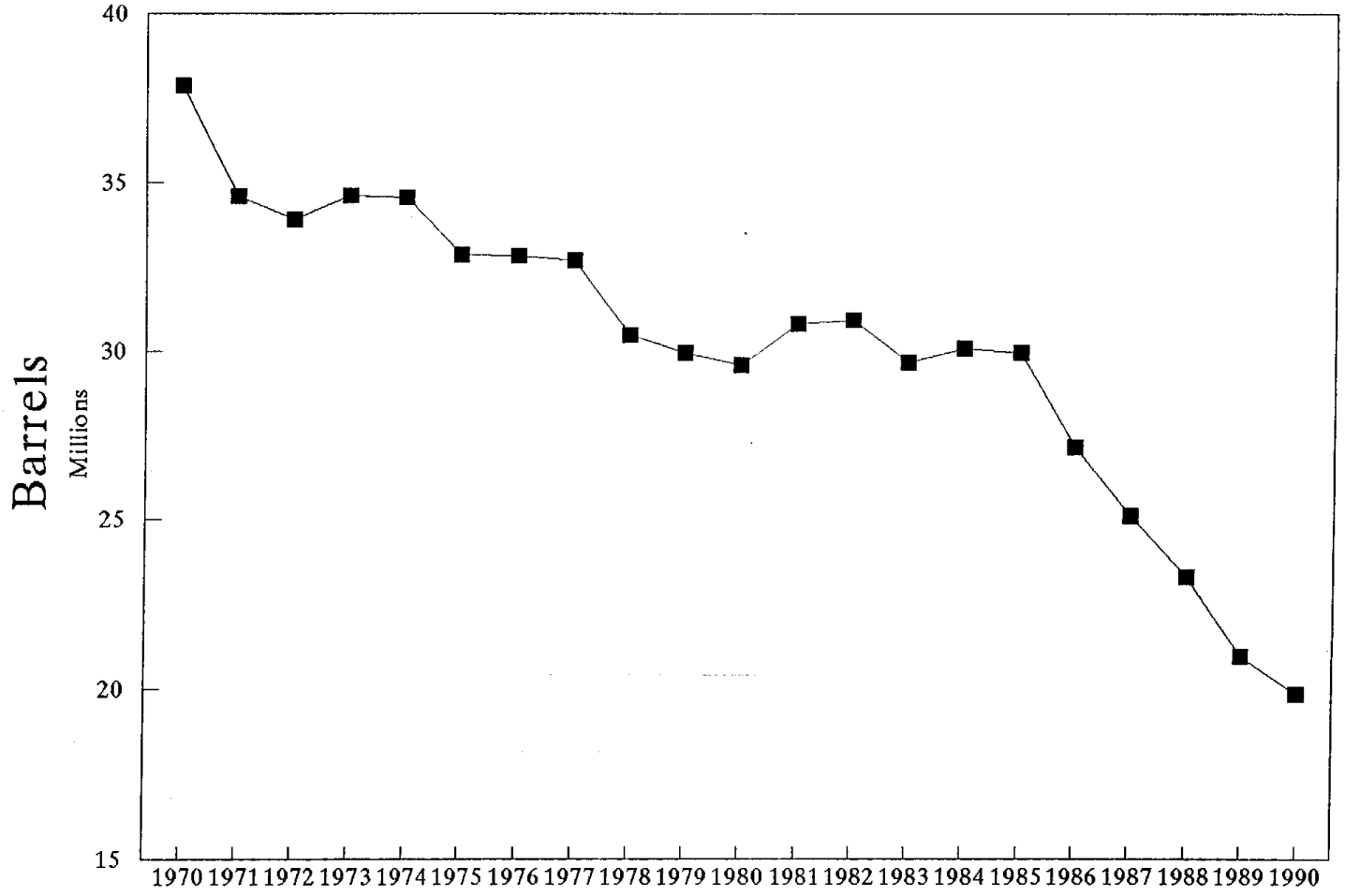
SUBBITUMINOUS COAL

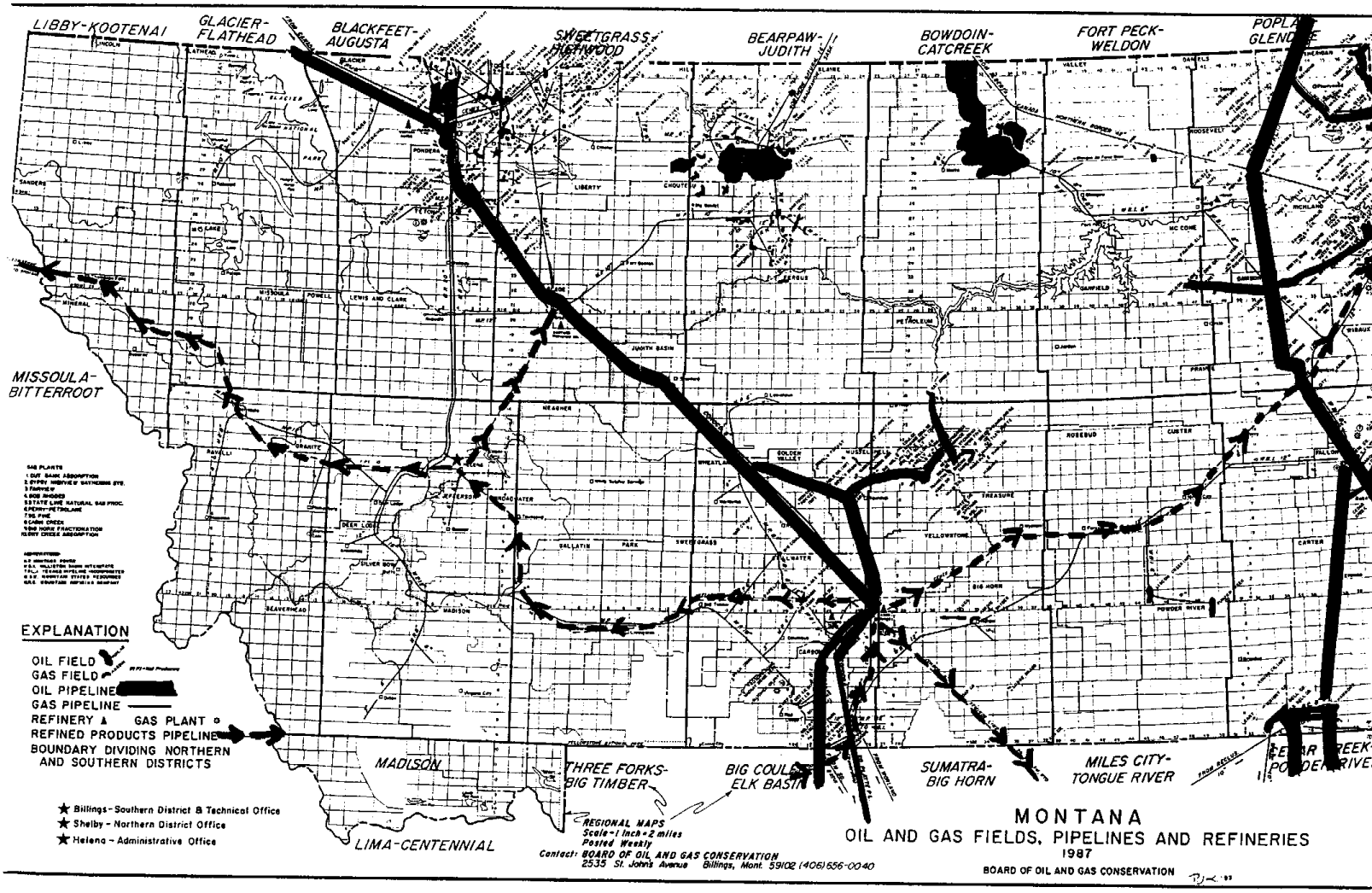
1970 – 1990



OIL PRODUCTION

1970 – 1990





MONTANA

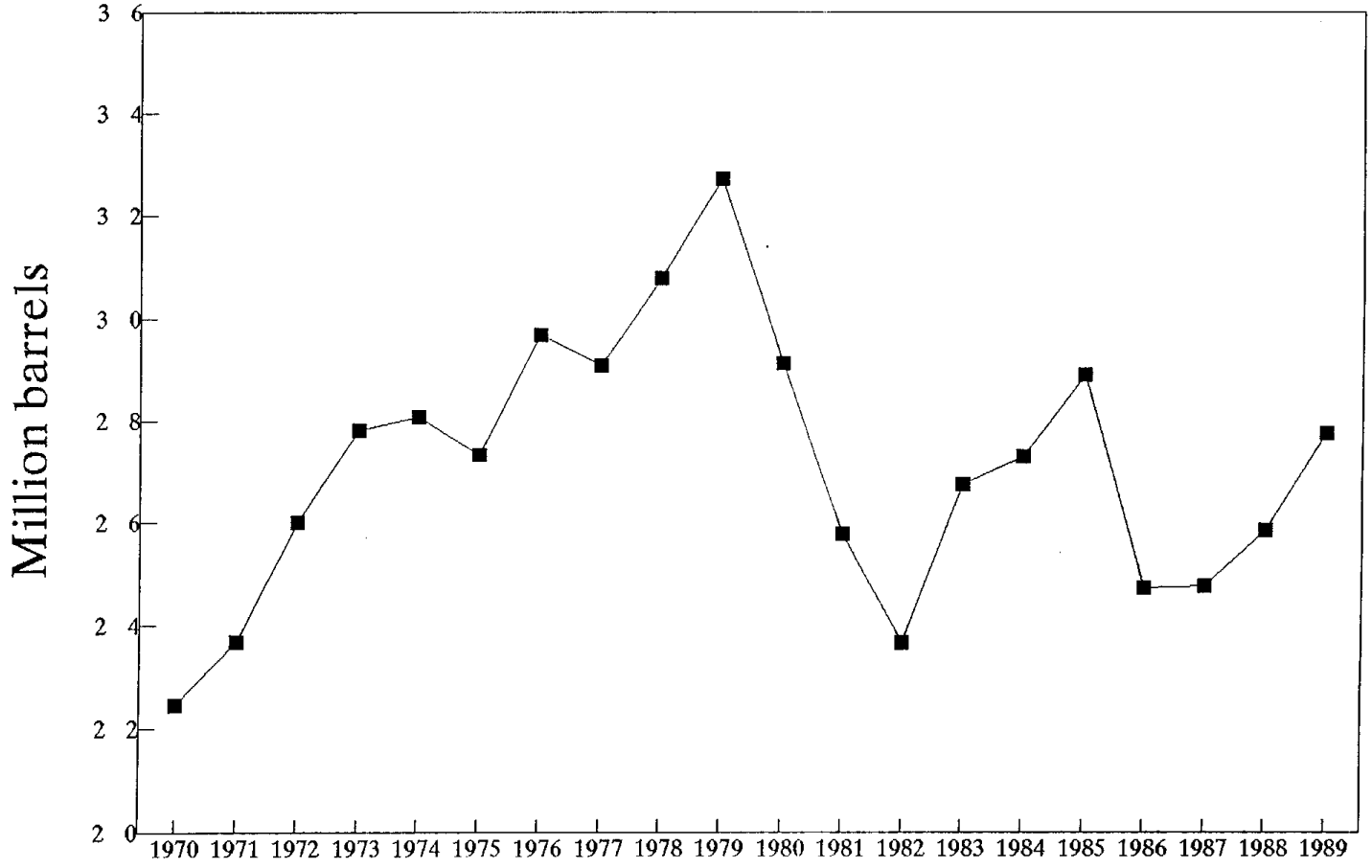
OIL AND GAS FIELDS, PIPELINES AND REFINERIES

1987

BOARD OF OIL AND GAS CONSERVATION

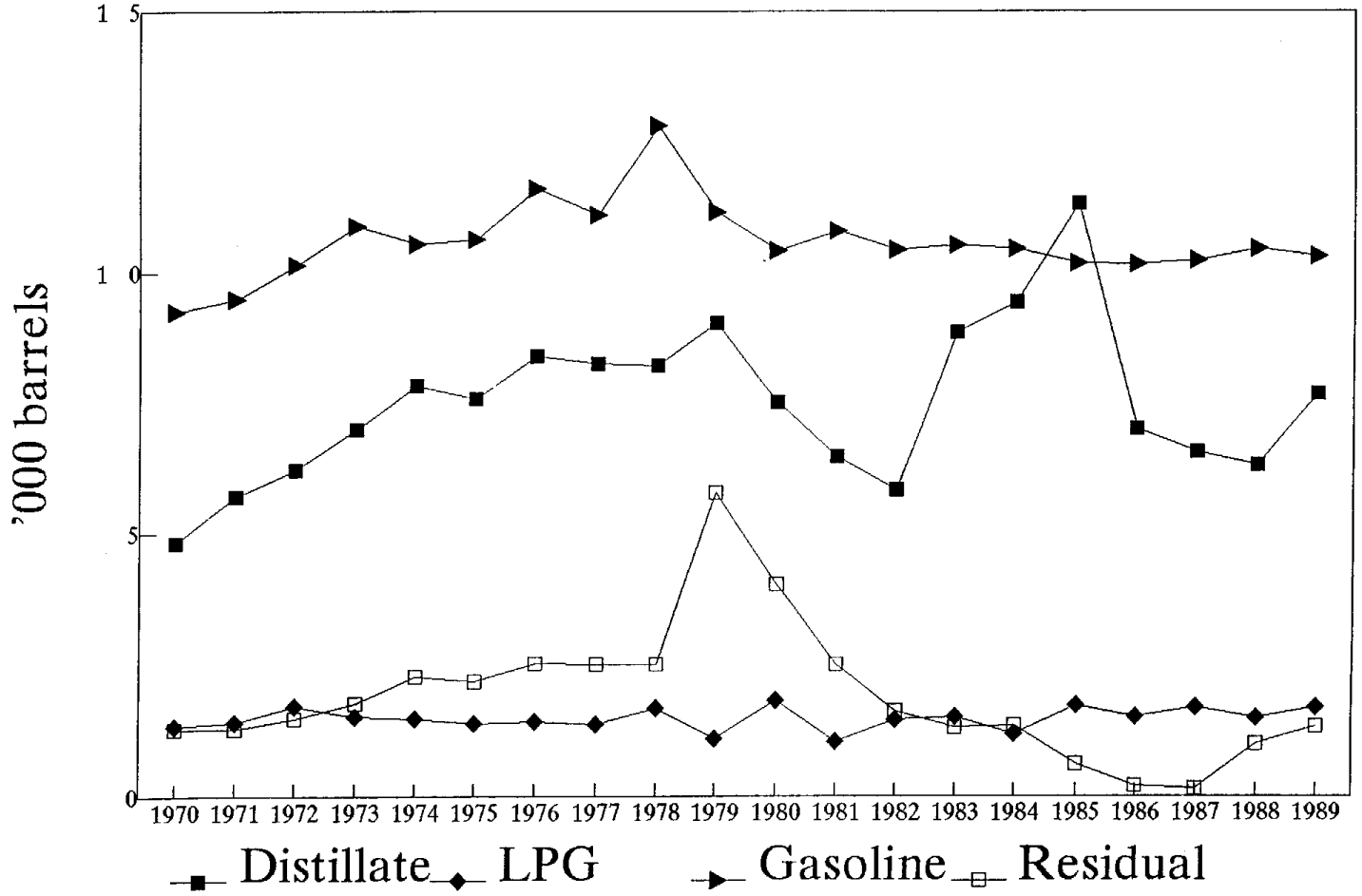
OIL CONSUMPTION

1970 – 1989



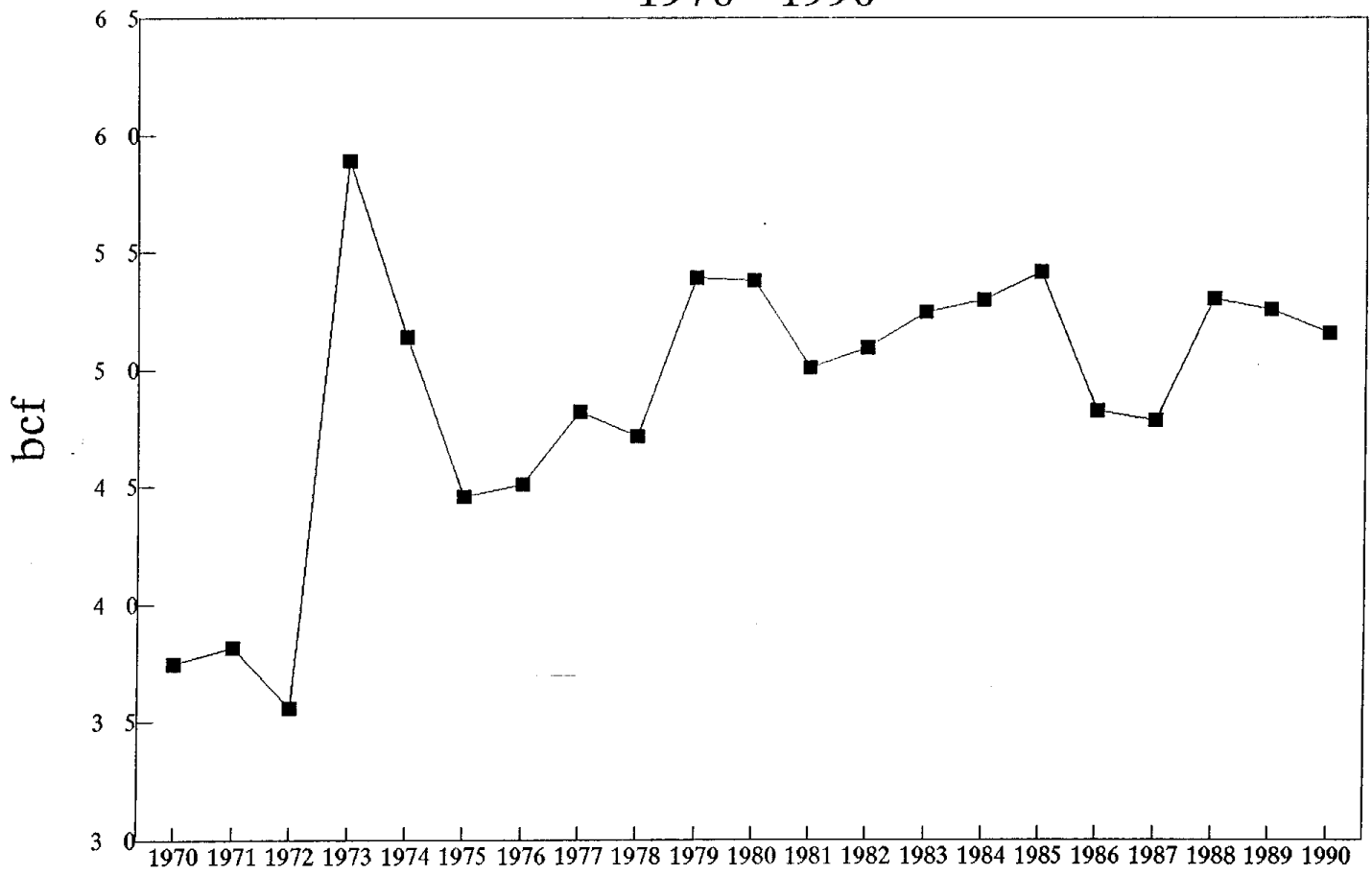
10

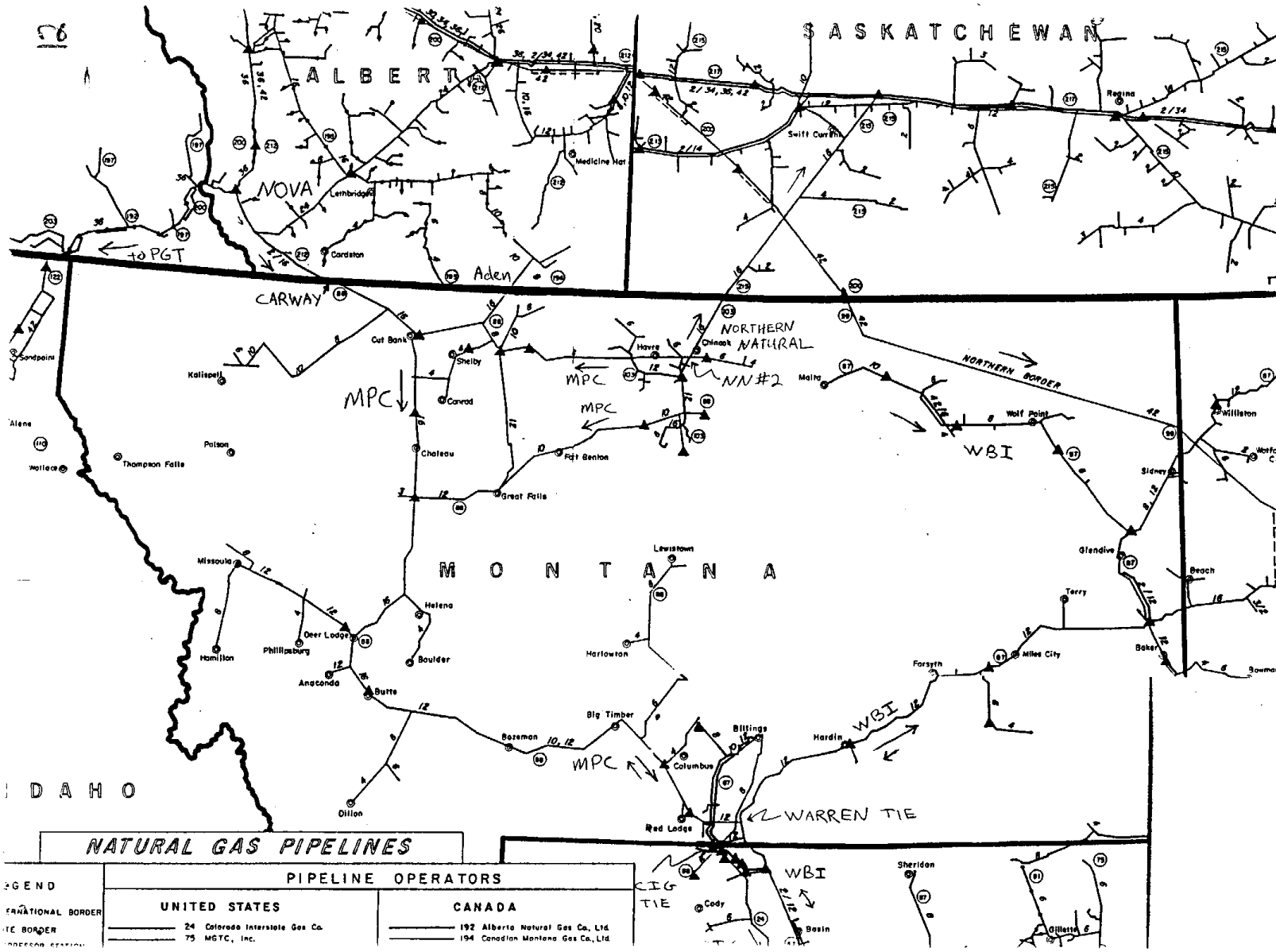
PETROLEUM PRODUCT CONSUMPTION
1970–1989



GAS PRODUCTION

1970–1990





NATURAL GAS PIPELINES

LEGEND

INTERNATIONAL BORDER

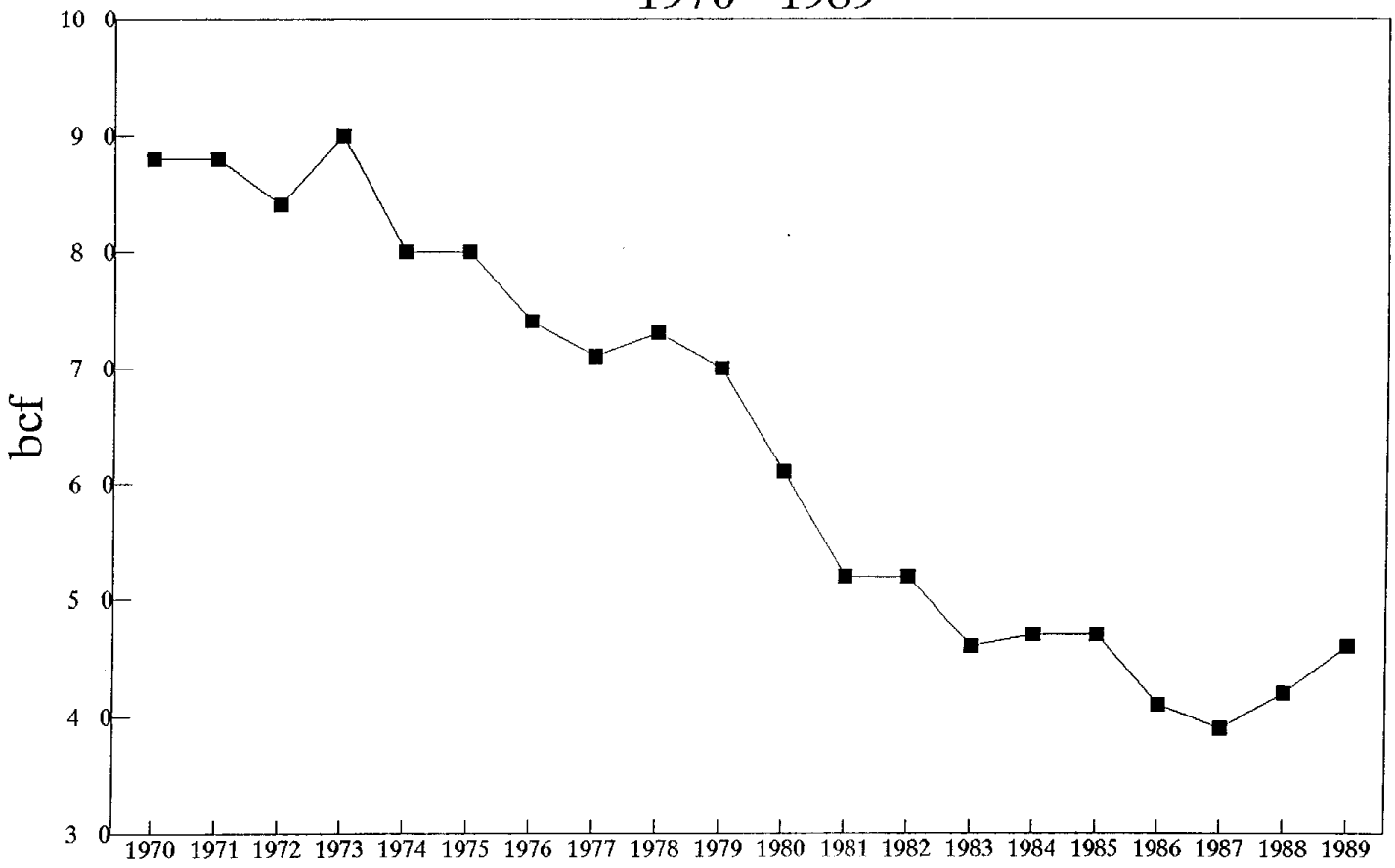
STATE BORDER

COMPRESSOR STATION

PIPELINE OPERATORS	
UNITED STATES	CANADA
24 Colorado Interstate Gas Co.	192 Alberta Natural Gas Co., Ltd.
75 MGTC, Inc.	194 Canadian Montana Gas Co., Ltd.

GAS CONSUMPTION

1970–1989



14

TABLE 2.1
ELECTRIC POWER PLANTS BY PRIMARY FUEL, 1989

HYDROELECTRIC PLANTS

Owner/Operator	Plant	County	Initial Year of Operation (First Unit)	Capacity[1] (megawatts)	CAPABILITY Critical Water Year (average MW)	CAPABILITY Median Water Year (average MW)
Champion International Corp.	Lake Creek	Lincoln	1916	5.0	2.3	2.8
Montana Department of Natural Resources and Conservation	Broadwater	Broadwater	1989	10.0	6.2	7.1
Montana Power Company	Black Eagle	Cascade	1927	18.0	14.0	18.0
Montana Power Company	Cochrane	Cascade	1958	50.0	22.0	34.0
Montana Power Company	Flint Creek	Granite	1901	1.1	1.0	1.0
Montana Power Company	Hauser Lake	Lewis & Clark	1907	16.5	12.0	16.0
Montana Power Company	Holter	Lewis & Clark	1918	49.0	24.0	30.0
Montana Power Company	Kerr	Lake	1938	180.0	119.0	128.0
Montana Power Company	Milltown	Missoula	1906	3.4	2.0	2.0
Montana Power Company	Morony	Cascade	1930	47.0	25.0	36.0
Montana Power Company	Mystic Lake	Stillwater	1925	11.5	6.0	6.0
Montana Power Company	Rainbow	Cascade	1910	35.0	29.0	35.0
Montana Power Company	Ryan	Cascade	1915	60.0	41.0	56.0
Montana Power Company	Thompson Falls	Sanders	1915	40.0	35.0	34.0
Montana Power Company	Madison	Madison	1906	8.5	7.0	8.0
Pacific Power & Light Co.	Bigfork	Flathead	1910	4.0	3.0	3.5
U.S. Dept. of the Army, North Pacific Division Corps of Engineers	Libby	Lincoln	1975	525.0	180.0	220.0
U.S. Dept. of the Army, Missouri River Division, Corps of Engineers	Fort Peck	McCone	1943	185.0	83.0	119.0
Mission Valley Power Co.	Hell Roaring	Lake	1915	0.4	NA	NA
U.S. Dept. of the Interior, Bureau of Reclamation, Great Plains Region	Canyon Ferry	Lewis & Clark	1953	50.0	30.4	45.9
U.S. Dept. of the Interior, Bureau of Reclamation, Great Plains Region	Yellowtail	Big Horn	1966	250.0	60.3	103.9
U.S. Dept. of the Interior, Bureau of Reclamation, Pacific Northwest Region	Hungry Horse	Flathead	1952	285.0	96.0	108.0
Washington Water Power Co.	Noxon Rapids	Sanders	1959	467.0	152.0	215.0
TOTAL HYDROELECTRIC CAPABILITY				**2,301.4 megawatts**		

TABLE 2.1 (continued)

FOSSIL FUEL FIRED PLANTS

Owner/Operator	Plant	County	Initial Year of Operation (First Unit)	CAPABILITY		Fuel
				Capacity[1] (megawatts)	Average (average MW)	
Montana-Dakota Utilities	Glendive	Dawson	1979	34.8		natural gas; #2 fuel oil
Montana-Dakota Utilities	Lewis & Clark	Richland	1958	50.9		lignite
Montana-Dakota Utilities	Miles City	Custer	1972	24.2		natural gas; #2 fuel oil
Montana Power Company	Frank Bird	Yellowstone	1951	60.0	3.0	oil; natural gas
Montana Power Company	J.E. Corette	Yellowstone	1968	156.0	125.0	subbituminous coal
Montana Power Company and Puget Sound Power & Light	Colstrip I	Rosebud	1975	314.0	245.0	subbituminous coal
Montana Power Company, Puget Sound Power & Light	Colstrip II	Rosebud	1976	320.0	246.0	subbituminous coal
Montana Power Company Puget Sound Power & Light, Portland General Electric, Washington Water Power, and Pacific Power & Light	Colstrip III	Rosebud	1984	720.0	562.0	subbituminous coal
Montana Power Company Puget Sound Power & Light, Portland General Electric, Washington Water Power, and Pacific Power & Light	Colstrip IV	Rosebud	1985	720.0	562.0	subbituminous coal
TOTAL FOSSIL FUEL FIRED CAPABILITY				**2,399.9 megawatts**		

OTHER PLANTS

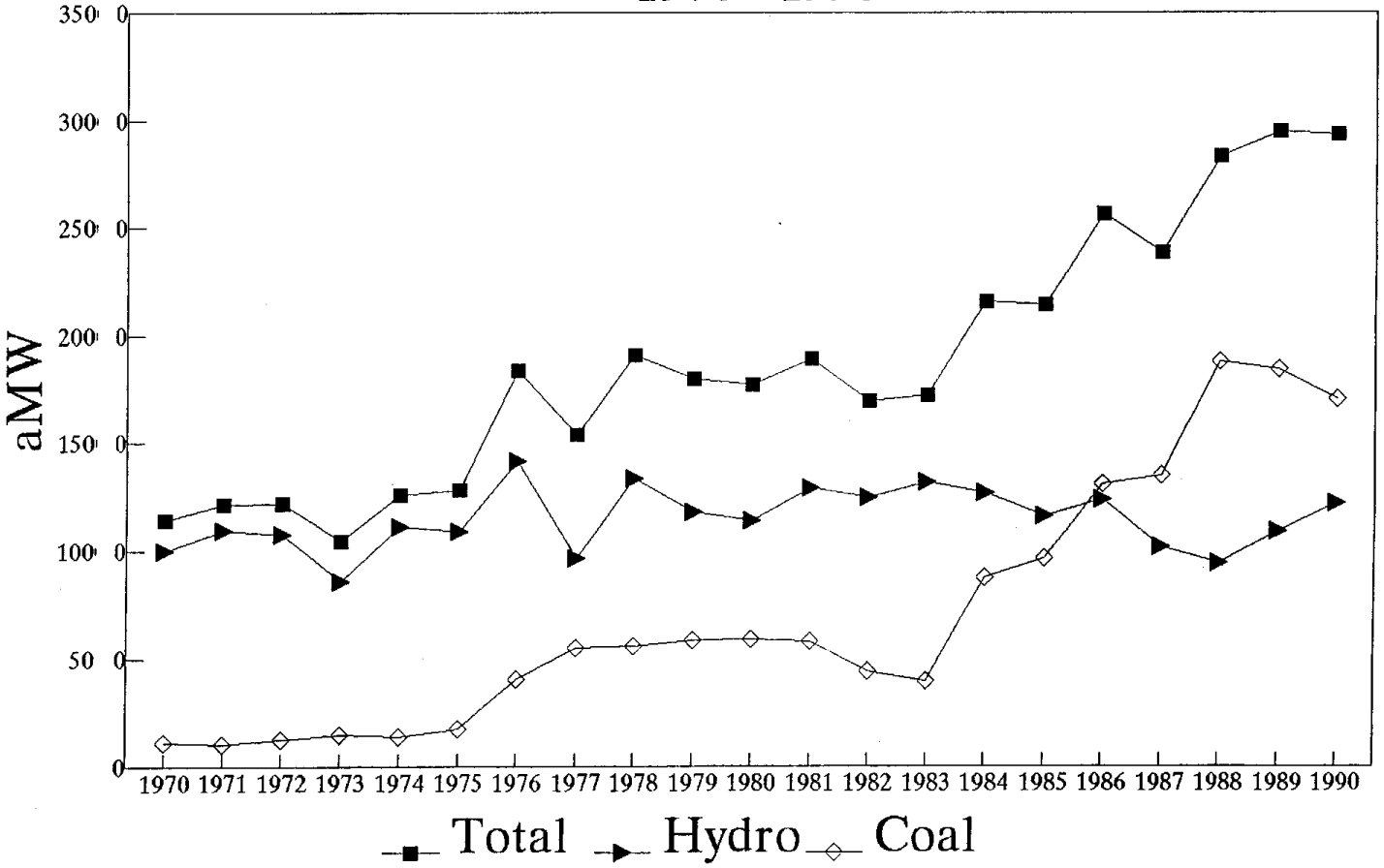
Owner/Operator	Plant	County	Initial Year of Operation (First Unit)	CAPABILITY		Fuel
				Capacity[1] (megawatts)	Average (average MW)	
Champion International Corp.	Libby	Lincoln	1939	12.5	7.6	wood and waste products
TOTAL CAPABILITY OF OTHER PLANTS				**12.5**		
TOTAL MONTANA GENERATING CAPABILITY				**4,713.8 megawatts**		

[1] Unless otherwise specified, capacity denotes installed nameplate capacity.

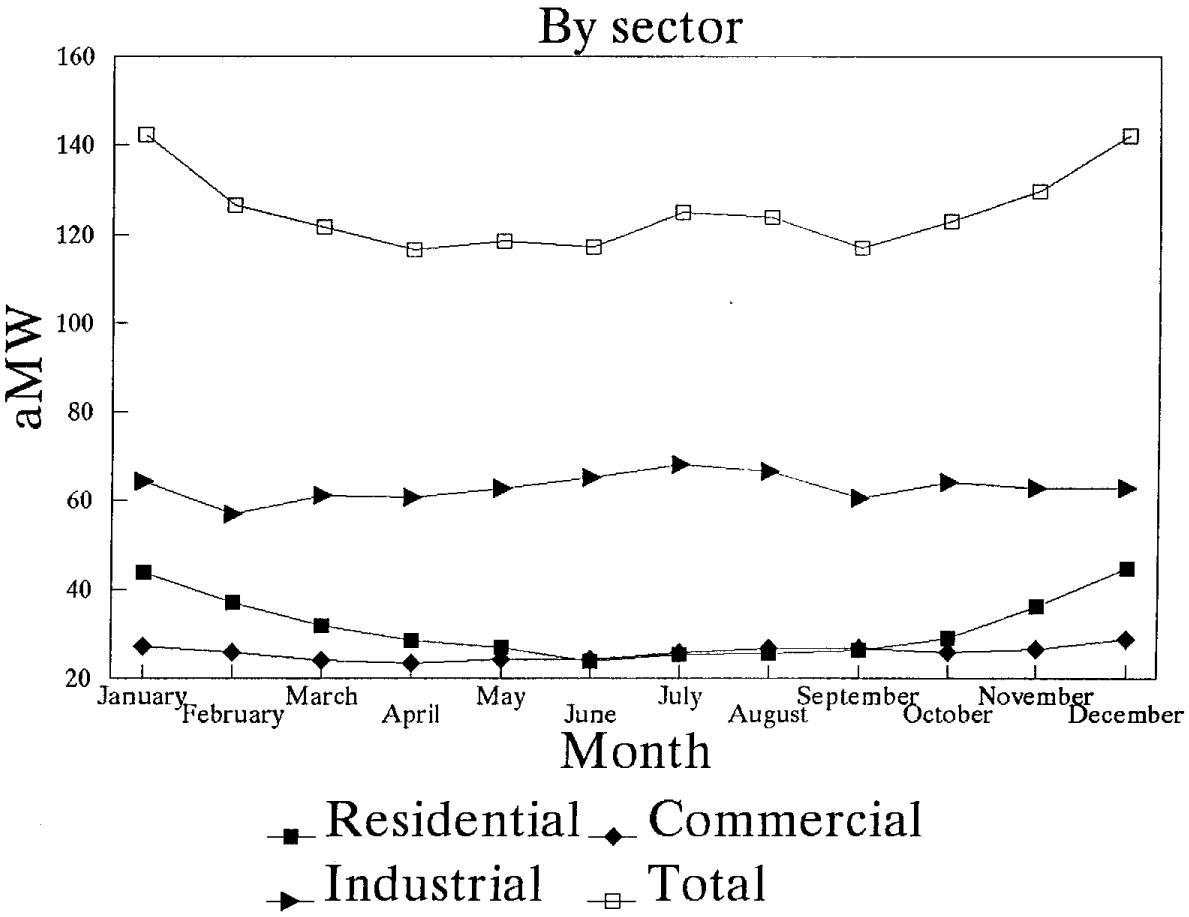
16

ELECTRIC GENERATION

1970–1990



1990 ELECTRICAL SALE



Based on Table 2.3, Historical Statistics

Retail Sales and Residential Customers

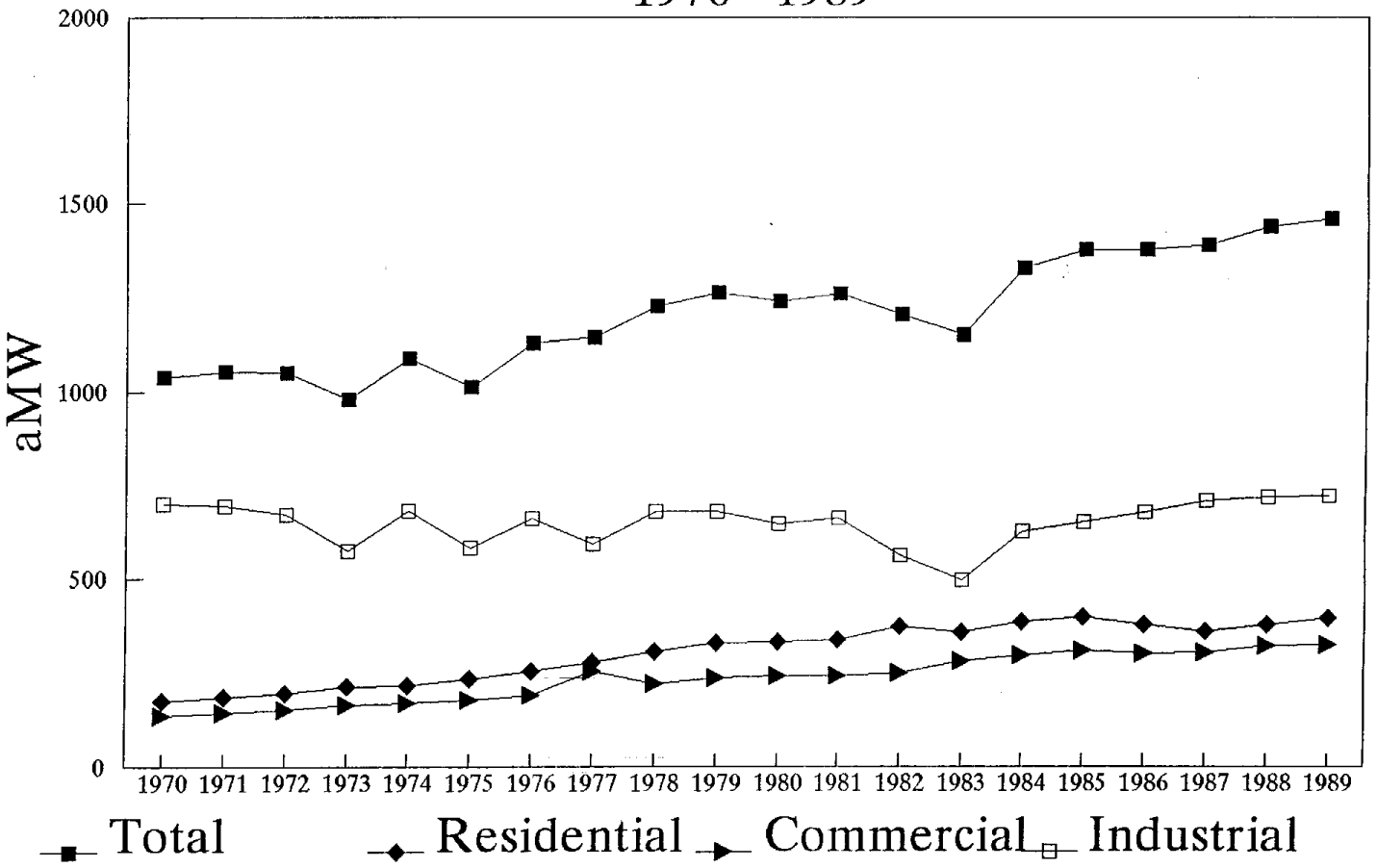
	Sales (aMW)	Customers
MPC	826.7	205,000
MDU	55.1	23,000
PP&L	79.5	25,000
BPA DSI	338.0	—
Western coops#	119.2	31,000*
Eastern coops	111.2	34,000*
Total	1530.0	318,000

* Number of residential customers for coops was estimated.

\# Western coops are those served by BPA. They're located in the western third of the state.

ELECTRICITY SALES

1970 – 1989



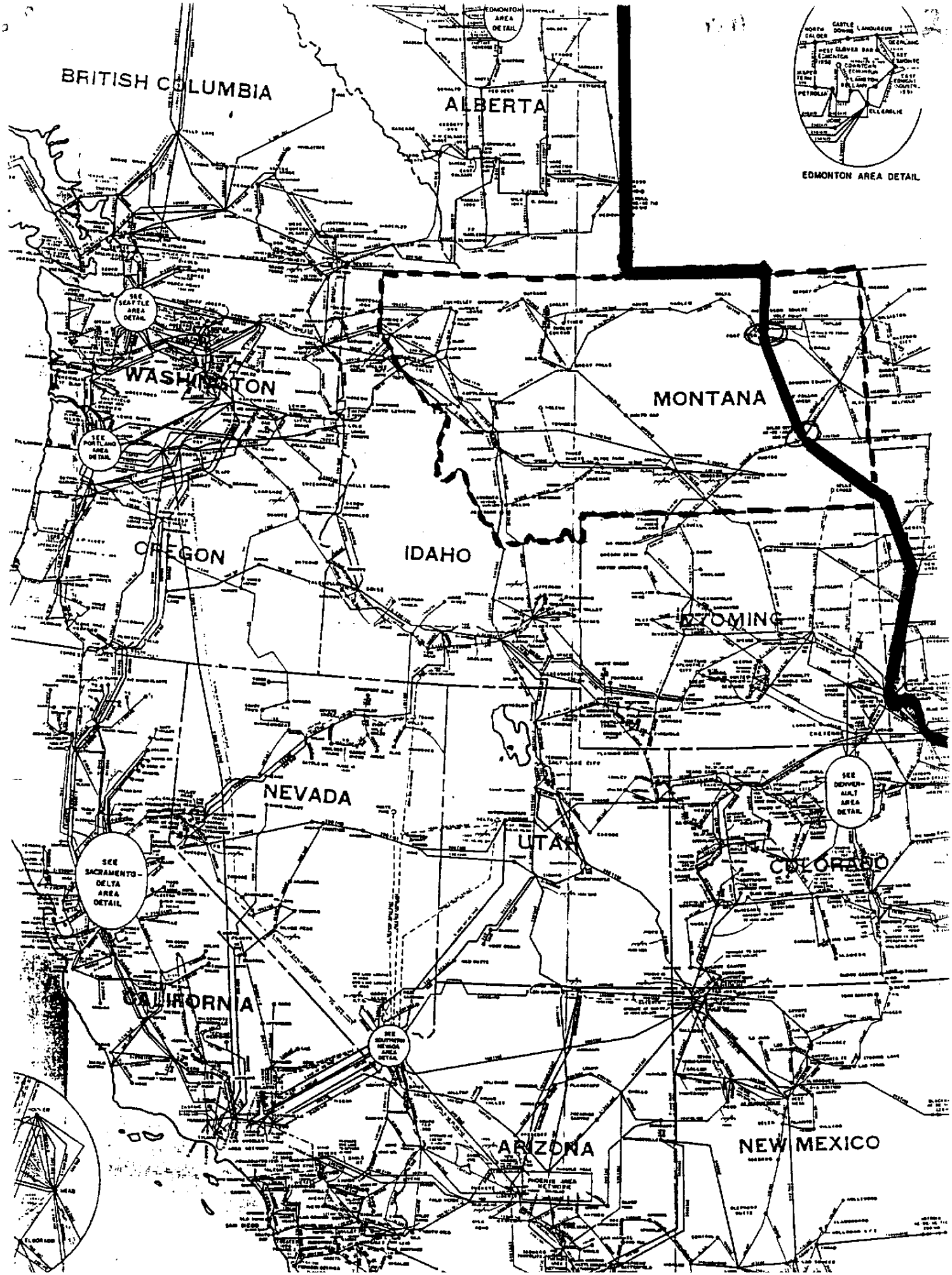
State-wide Sales by Sector, 1990

Residential	378.9 aMW
Commercial	309.0
CFAC	338.0
Other industrial	418.4
Other	59.2
Total Sales	1503.4 aMW

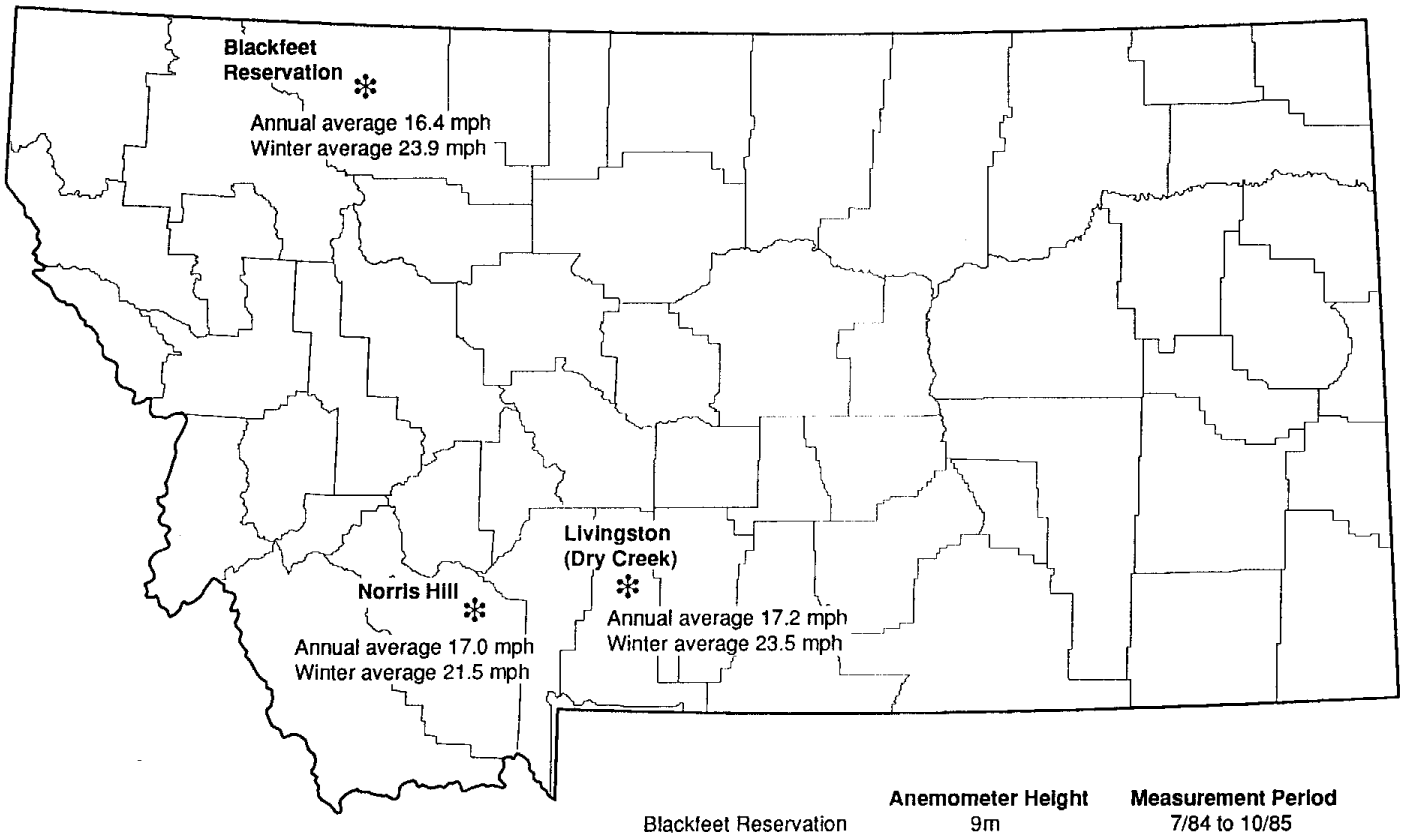
Line losses (est. 10%) 167.0
Total system requirements 1670.5 aMW

Exports (est)1265.3 aMW

NOTE: Commercial and industrial end-use figures may be influenced by rate category definitions as well as by the actual nature of the businesses.


BRITISH COLUMBIA
ALBERTA
EDMONTON AREA DETAIL
EDMONTON AREA DETAIL
SEE SEATTLE AREA DETAIL
WASHINGTON
MONTANA
SEE PORTLAND AREA DETAIL
OREGON
IDAHO
WYOMING
NEVADA
UTAH
SEE DENVER-BOULDER AREA DETAIL
COLORADO
SEE SACRAMENTO-DELTA AREA DETAIL
CALIFORNIA
SEE SOUTHERN NEVADA AREA DETAIL
ARIZONA
NEW MEXICO

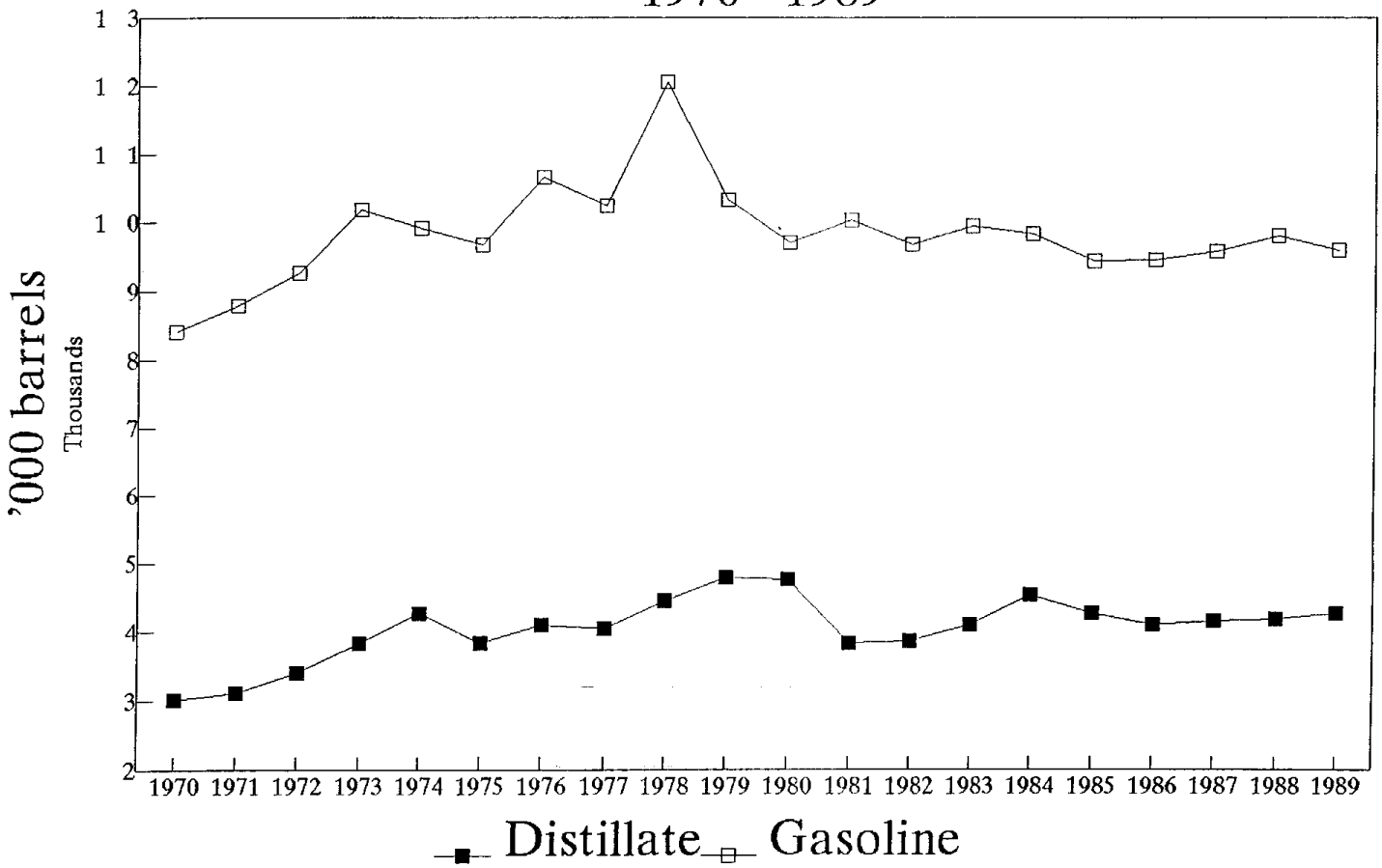
Potential Wind Sites



	Anemometer Height	Measurement Period
Blackfeet Reservation	9m	7/84 to 10/85
Livingston (Dry Creek)	10m	11/85 to 11/87
Norris Hill	10m	1/84 to 3/86

TRANSPORTATION FUEL

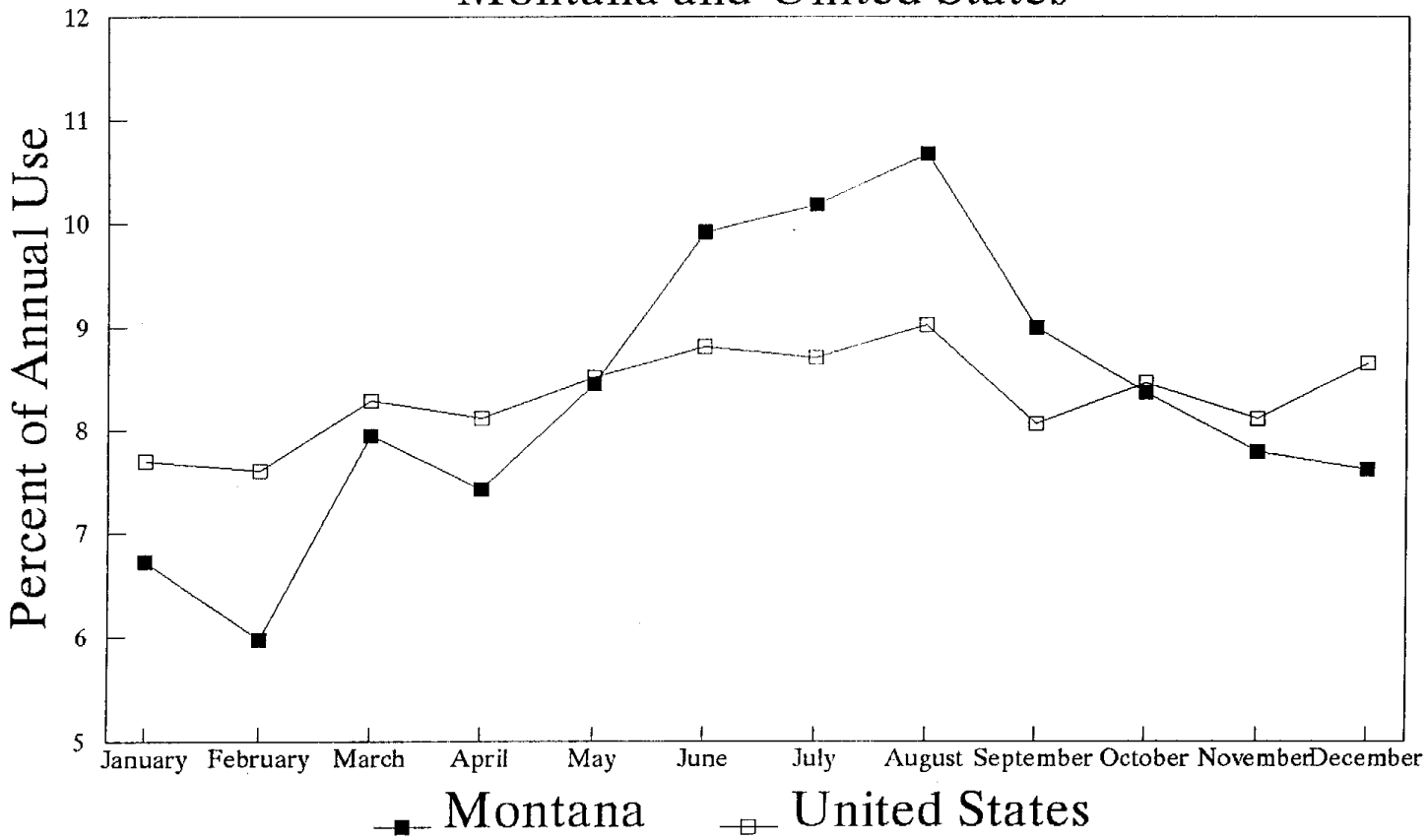
1970–1989



24

GASOLINE USE 1989

Montana and United States



Based on gross gallons of gasoline reported by wholesale distributors.
This may reflect a month or more lag between wholesale and retail sales.

FLEET EFFICIENCY